16 Smithville Lake

16.1 General Background

Smithville Lake was impounded in 1979 and reached multipurpose pool elevation on 11 June 1982. The primary water quality threats in the Smithville Lake watershed include nutrients, herbicides, sedimentation, and bacterial contamination. The lake is listed on the state's 303(d) list for water quality impairment due to mercury contamination. The Smithville Lake Watershed Coalition (SLWC), formed in 1997, is a citizen-based watershed group active within the Smithville Lake watershed. The SLWC developed a Missouri DNR approved watershed management plan during 2005 to address water quality issues related to nutrients, contaminants, sediment, and bacterial contamination. The Missouri Department of Conservation has conducted aquatic vegetation introduction efforts at the lake to since 1998. The Corps of Engineers Waterways Experiment Station and the Missouri Department of Conservation have worked together to reduce shoreline erosion resulting from water level fluctuations and wave action. Techniques include planting willow wattling bundles and coyier rolls along the shoreline to dissipate wave energy. This not only reduces shoreline erosion but also protects newly planted aquatic vegetation. Additional benefits of the aquatic vegetation plantings include creating spawning and nursery habitat for fish, as well as uptake of excess nutrients in the water. Enclosures are used around the plantings to reduce wave action and reduce damage by foraging rough fish, namely carp. Woody plant species, primarily willow, will be planted at higher elevations in hopes of holding soil in place in times when the lake pool fluctuates above multipurpose pool. A variety of woody tree and shrub species will be experimented with to determine which species are best adapted to the lake shore environment. The effort expended will pay great dividends in the future to improved water quality, fishing habitat, and the aesthetic value for Smithville Lake.

16.1.1 Location

Smithville Lake is located approximately 32 km (20 miles) north of Kansas City, Missouri (Figure 16.1). The dam is located at river kilometer 20.6 (river mile 12.9) on the Little Platte River, a tributary of the Platte River. The watershed covers over 126,000 acres within the counties of Clay, Clinton, and Dekalb. Historic water quality sample sites include 1 inflow, 3 lake, and 1 outlfow.

16.1.2 Authorized Purposes: Water supply, flood control, water quality improvement, recreation, and fish and wildlife management.

16.1.3 Lake and Watershed Data

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	876.2	101.7	10,000	
Multipurpose	864.2	139.8	7,190	175
Total		241.5		

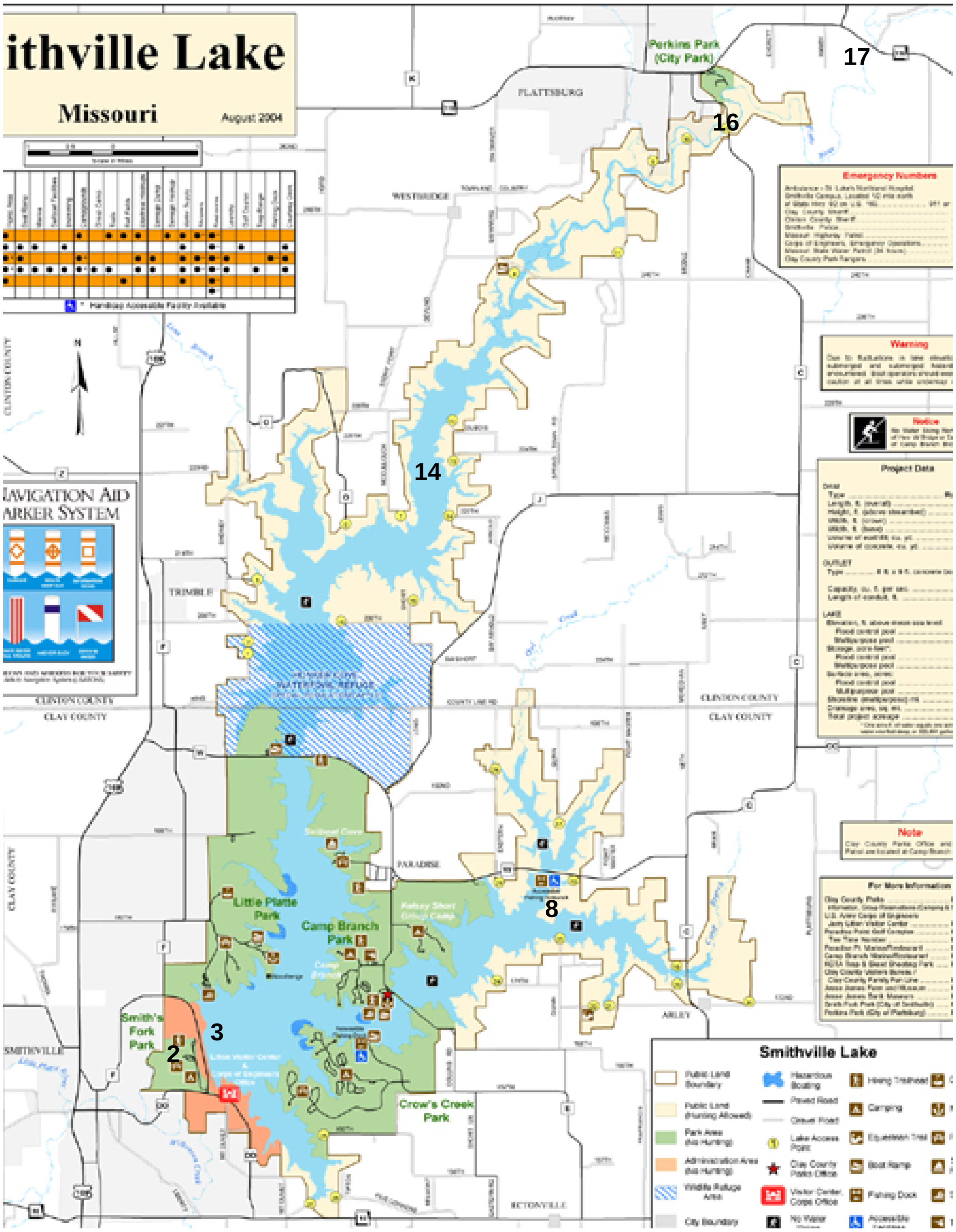


Figure 16.1. Smithville Lake area map with sample site locations.

Total watershed area: 213 sq miles (136,320 A)

Watershed ratio: 13.62 FC / 18.96 MP

Average Annual Inflow: 133,248 acre-feet
Average Annual outflow: 000 acre-feet
Average flushing rate:
Sediment inflow (measured): 4,987 acre-feet (1979 – 1993)

16.2 2005 Activities

Smithville Lake staff (OF-SM) providing field sampling assistance during 2005 was Derek Dorsey, Federal Park Ranger. Bruce Clark, OF-SM Operations Manager, provided insight and background regarding Smithville Lake.

16.3 2005 Data

Comparative historic data consists of monthly (April – September) data collected from 1997 through 2005.

16.3.1 Inflow

Inflow samples were collected from a single inflow site (Site 16) located just downstream from the city of Plattsburg, Missouri. Data results will be discussed with lake specific data below.

16.3.2 Lake

Nitrogen is one of the most critical elements related to water quality. Sources of nitrogen within the watershed include: fertilizers, septic tanks / lagoons, and WWTP. Median total nitrogen (TN) concentrations from surface samples collected between 1997 and 2005 ranged from 0.7 – 0.9 mg/L (Figure 16.2). The highest median concentration and most variability are attributed to inflows from the upper watershed (Site 16). Although these median values are some of the lowest measured in the district, they do exceed EPA's proposed ecoregional nutrient criteria (0.36 mg/L). As expected, annual and monthly variability is very apparent for TN concentrations – see Figure 16.3 as an example from Site 14 (Little Platte arm).

Phosphorous is the other critical element related to water quality issues, especially related to algal communities. Phosphorous sources within the watershed include fertilizers (primarily bound to sediment), soaps / detergents, and waste byproducts. Median total phosphorus (TP)concentrations range from 0.05 – 0.1 mg/L from surface water samples collected from 1997 through 2005 (Figure 16.4). Similar to TN, the highest median concentrations and most variability are measured at the upper end of the lake (Site 16). All median TP concentrations exceed EPA's proposed ecoregional nutrient criteria value of 0.02 mg/L. Smithville Lake TP concentrations are typical of other large reservoirs in northern Missouri (LMVP 2004) and within the district.

The ratio of TN:TP can be used as a surrogate to determine the dominant algal community within a waterbody. Ratios $\geq$ 20:1 are indicative of desirable algal communities, whereas ratios $\leq$ 12:1 are indicative of bloom-forming cyanobacteria (blue green algae). As would be expected, there is high monthly and annual variability in the TN:TP ratio at all sites; see Figure 16.5 as an example at Site 3 (Tower). Median TN:TP ratios are < 12 for Sites 14 (Little Platte arm) and 8 (Camp Branch arm), indicating the lake is at risk for cyanobacteria blooms (Figure 16.6). Microcystin toxins have been detected at Smithville Lake during 2000 and 2001 (Dr. Jennifer Graham, USGS, personal communication).

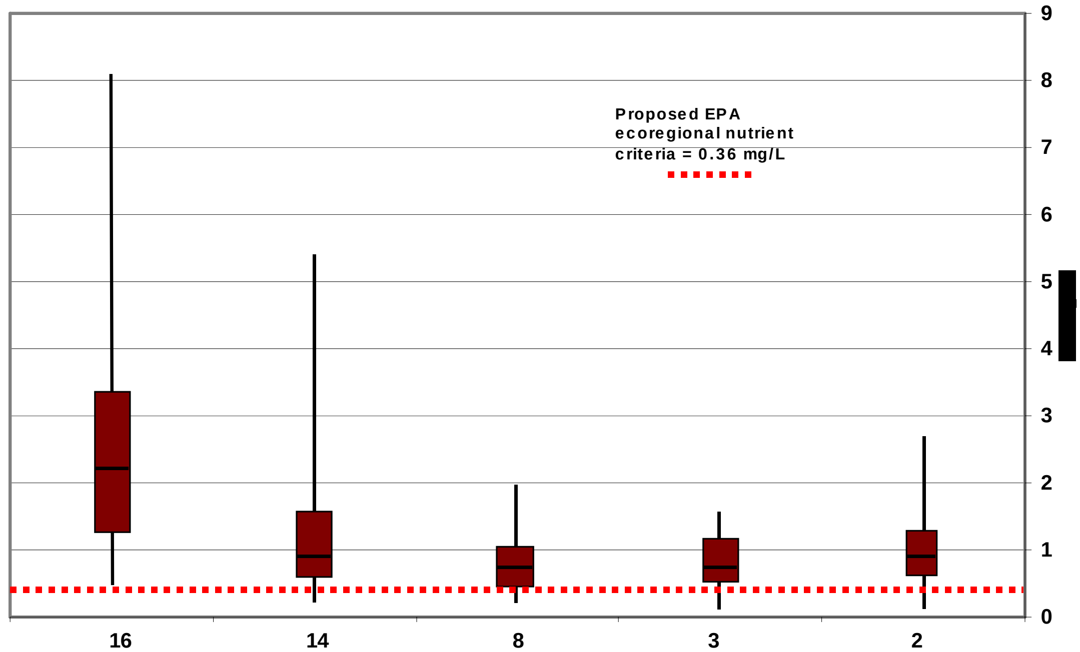


Figure 16.2. Box plots of surface water sample total nitrogen (TN) concentrations measured by site at Smithville Lake from 1997 through 2005.

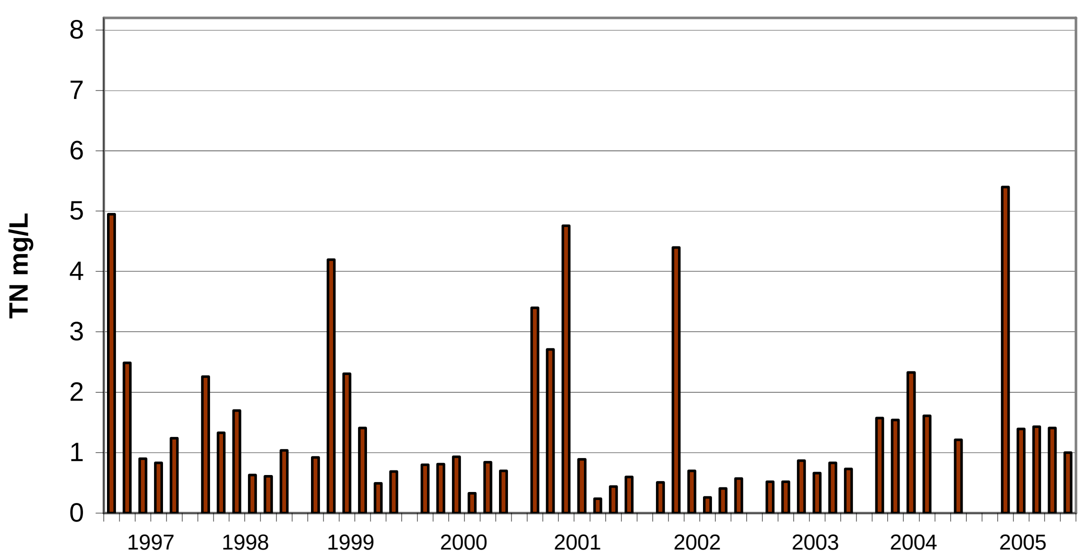


Figure 16.3. Total nitrogen (TN) concentrations from surface samples by date and year from Site 14 (Little Platte arm) in Smithville Lake from 1997 through 2005.

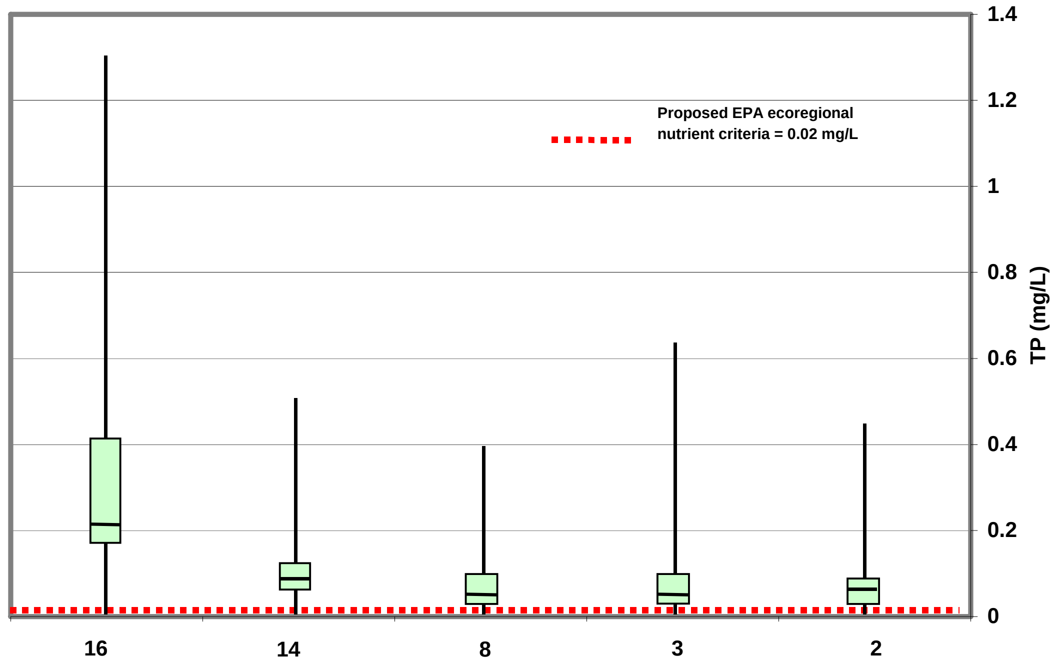


Figure 16.4. Box plots of surface water sample total phosphorus concentrations measured by site from 1997 through 2005 at Smithville Lake.

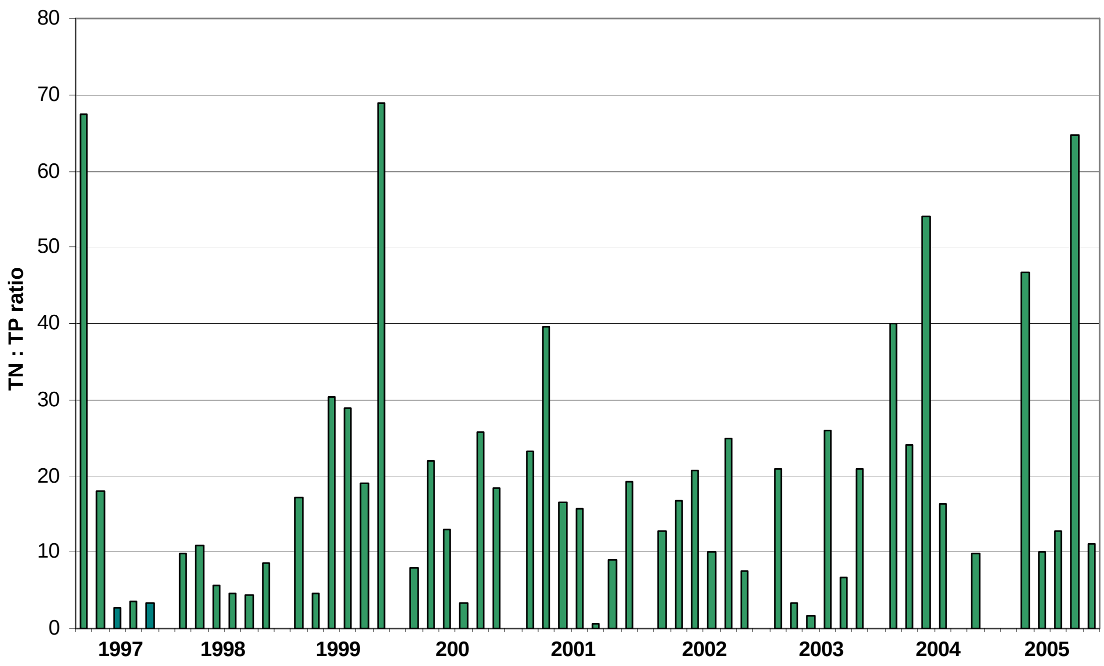


Figure 16.5. Graph of total nitrogen : total phosphorus (TN : TP) ratio by sample date from 1997 through 2005 at Site 3 (Tower) in Smithville Lake.

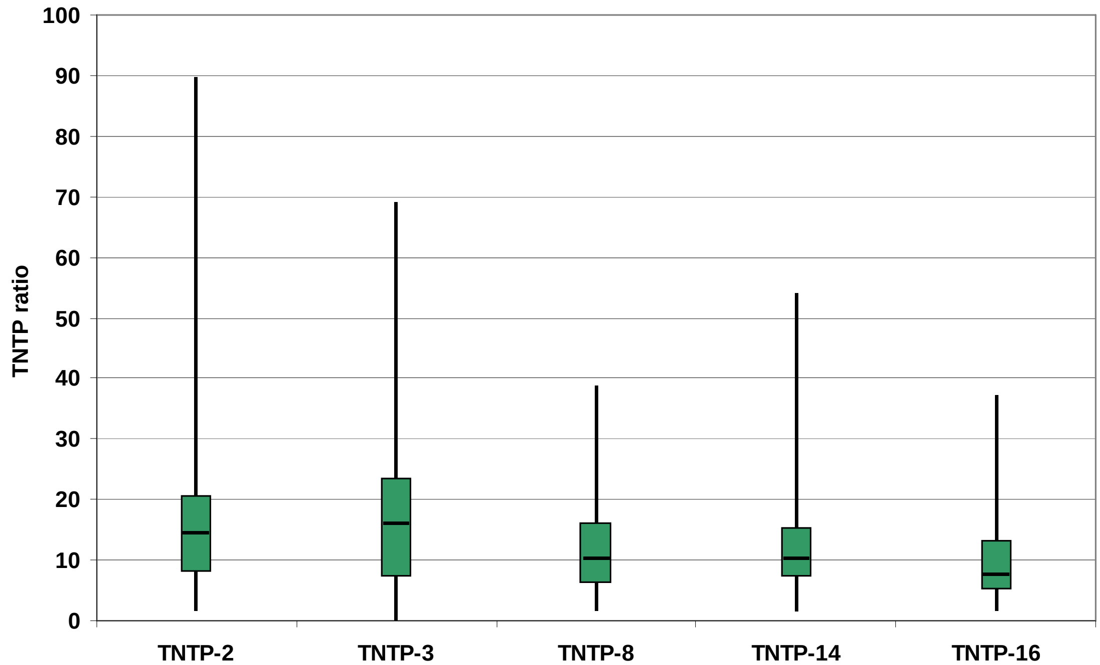


Figure 16.6. Box plots of total nitrogen : total phosphorus (TN : TP) concentrations by site from 1997 through 2005 at Smithville Lake.

Major reductions in atrazine application rates (from 4.0 to 1.6 - 2.5 lbs active ingredient per acre), have resulted in improved water quality at Smithville Lake. The mean atrazine levels in Smithville Lake's raw water have declined from 2.37 ug/L in 1997 to 1.68 ug/L in 2004, which is less than EPA's drinking water maximum contaminant level (MCL) of 3 ug/L. Differences in median concentrations of atrazine from 1997 - 2005 are very noticeable between water quality monitoring sites at Smithville Lake (Figure 16.7). For reference, Site 2 is located just below the dam outflow, Site 3 is located within the lake near the dam (deep water site), Site 8 is located in the Camp Branch arm of the lake, Site 14 is located near Trimble, and Site 16 is located on the Little Platte River prior to the confluence of the lake. (Figure 16.1). The highest concentrations and most variability in data are from the Plattsburg site (Site 16), with median concentrations decreasing in a down-lake progression. When examined on a monthly basis during this time period, highest concentrations are measured during spring, which coincides with application, rainevents, and runoff. Figure 16.8 depicts monthly and annual differences in atrazine concentrations measured at Site 16 (Little Platte inflow) from 1997 through 2005 – notice the 9 ug/L spike measured during 2005! This indicates that additional BMP's need to be installed in the upper watershed to reduce future herbicide runoff.

Mean chlorophyll *a* concentrations from samples collected during 2005 ranged from 28 to 46 ug/L for samples collected during June, August and September. These concentrations are some of the highest recorded within the district, and are much higher than the long-term median values. Median values for chlorophyll samples collected between 1997 and 2005 ranged from 12ug/L (Site 3 – tower) to 20 ug/L (Site 14 – Little Platte arm)(Figure 16.9). Differences in water clarity, as measured my secchi depth, were detected between lake sites. Median secchi depths were significantly greater at Site 3 (0.98 m; Tower) vs the more productive Site 14 (0.6 m)(Figure 16.10).

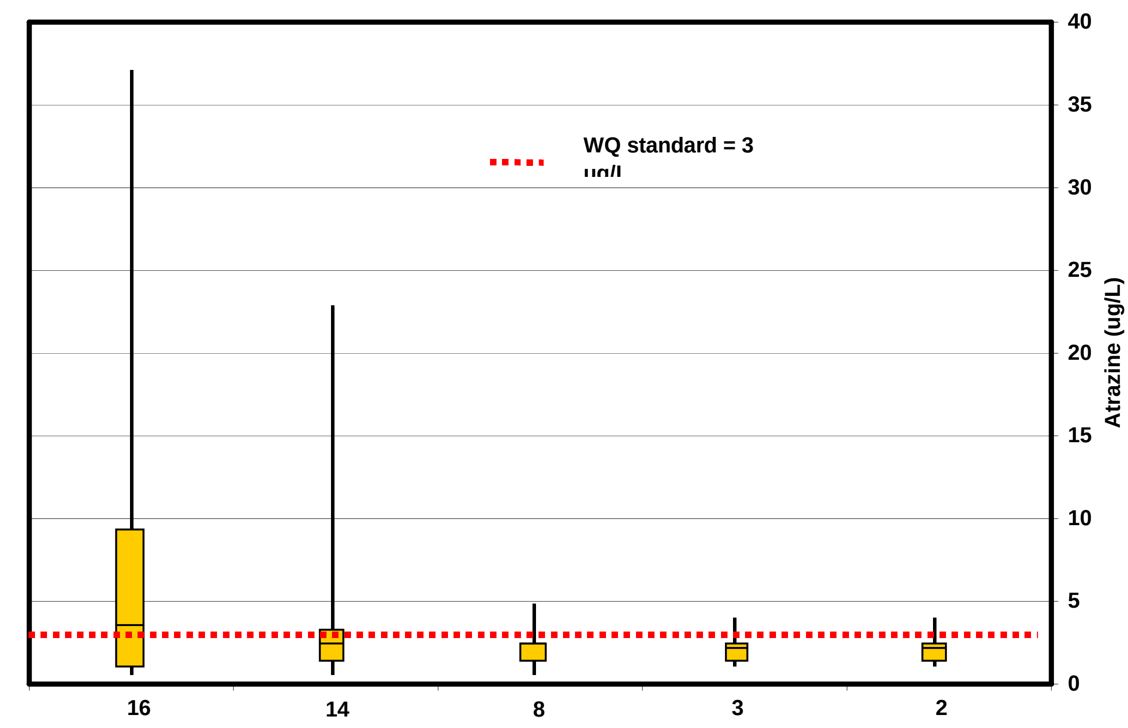


Figure 16.7. Box plots of surface water sample atrazine concentrations measured by site from 1997 through 2005 at Smithville Lake.

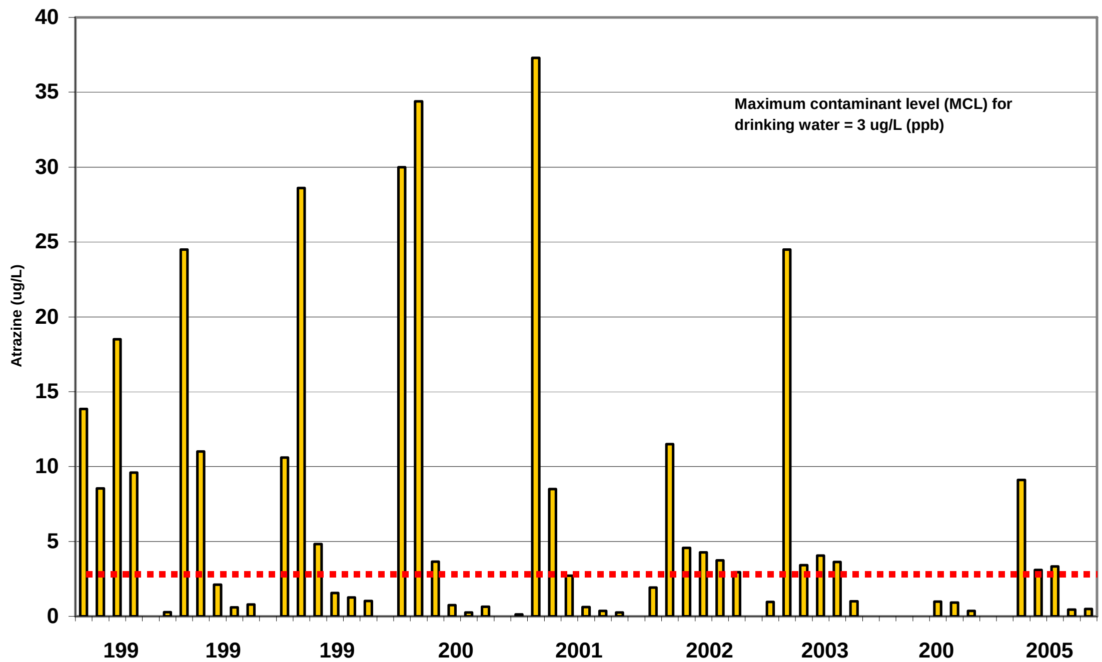


Figure 16.8. Atrazine concentrations by sample date collected at Site 16 (Little Platte inflow) in Smithville Lake from 1997 through 2005.

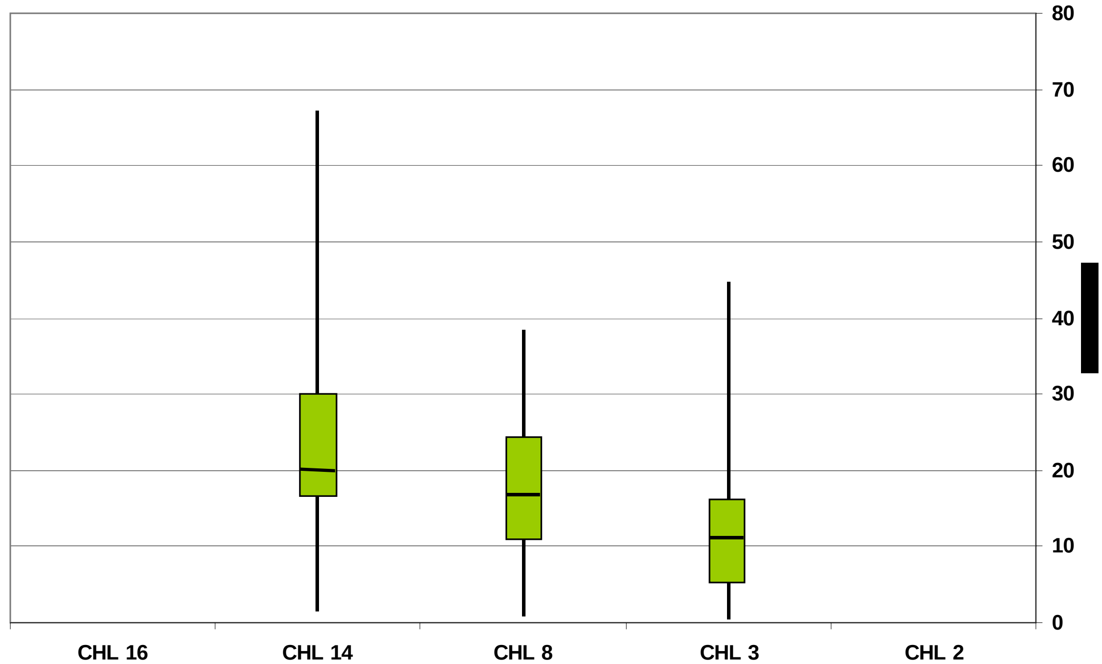


Figure 16.9. Box plots of chlorophyll a values measured by site at Smithville Lake from 1997 through 2005.

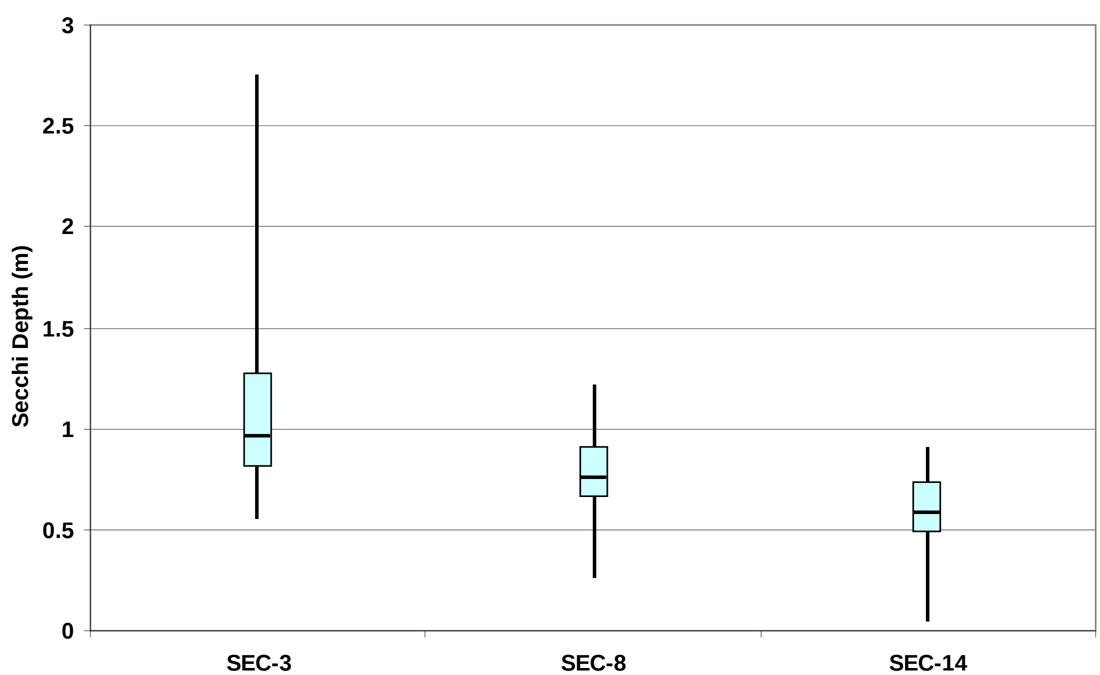
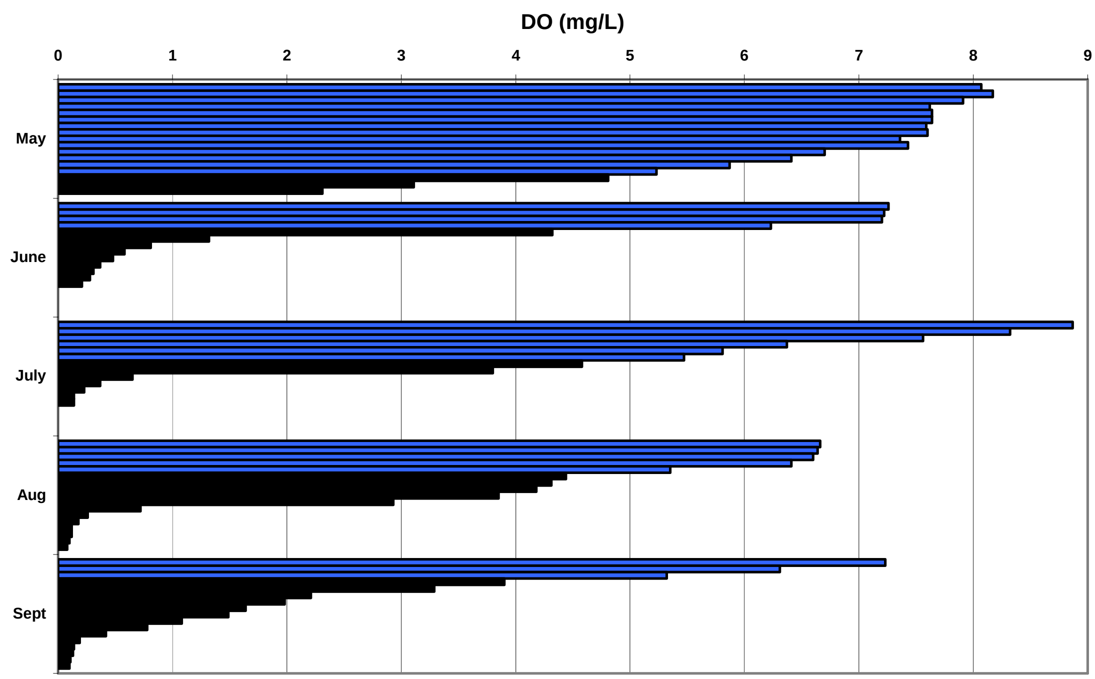


Figure 16.10. Box plots of secchi depth measurements by site in Smithville Lake from 1997 through 2005.

Total iron exceeded EPA's Drinking Water Standard of Secondary Maximum Contaminant Levels (SMCL) of 300 ug/L from surface samples collected during August from Sites 2 (outflow), 14 (Little Platte arm) and 16 (Little Platte inflow). Concentrations ranged from 222 (Site 8) to 3648 (Site 16), indicating possible inputs upstream of the lake in the Little Platte. Implications are directed at drinking water facilities related to taste and staining issues. In addition, all surface samples collected during August exceeded EPA's SMCL for manganese (50 ug/L). Sample concentrations ranged from 59 – 240 ug/L, with highest concentrations measured at Site 16 (Little Platte inflow). Implications are directed at drinking water facilities due to taste and stain issues.

A lake profile can provide insight into depth of lake stratification and mixing depending upon the time of year and location within the lake. Profile parameters include temperature, dissolved oxygen, pH, conductivity, and turbidity. Based on monthly profiles in 2005, stratification was prevalent from June through September (Figure 16.11). The graphs indicate that water temperatures gradually decrease from the surface down to approximately 4 m (12 ft), before beginning a gradual cooling to 8 m (21 ft) after which it rapidly cools with increasing depth. This transition from warm to cool waters is the thermocline – an area important to fishermen as well as water supply intakes! Within this transition zone, available oxygen rapidly declines from 7 mg/L to nearly 0 mg/L. This anoxic layer (no oxygen) drives many water quality functions within the lake, including phosphorous release and ammonia buildup — these are released in fall when the lake undergoes 'turnover'. An increase in nutrients inputs into the lake ultimately reduces the depth at which the lake stratifies. This will impact depths at which fish can occupy (resulting in loss of habitat), and impacts quality of drinking water (ie, flavor, filtration, cyanobacteria).



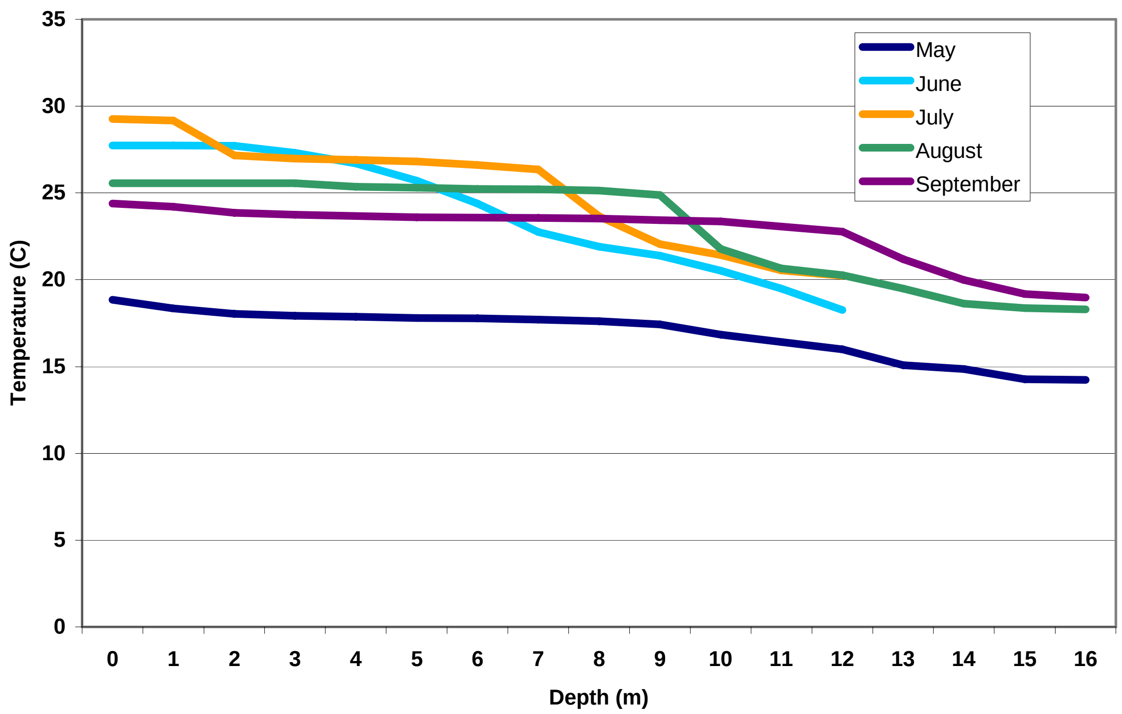


Figure 16.11. Dissolved oxygen concentration (mg/L) histogram and temperature (°C) plot from vertical profiles conducted during 2005 at Site 3 (Tower) in Smithville Lake.

16.3.3 Outflow

Outflow samples were collected during 2005 from the stilling basin (Site 2). A description of this data is incorporated into the lake section above.

16.4 Future Activities and Recommendations

Sampling activities for 2006 will include transition from 'intensive' to 'ambient' monitoring from April through August, as well as conducting monthly vertical profiles at each of the three lake sites. In addition, a second inflow site will be added (Site 20) upstream of Plattsburg to monitor contaminants and baseline water quality parameters on the Little Platte River prior to reaching town. Continue interactions with the Smithville Lake Watershed Coalition, NRCS, and Missouri Department of Conservation to improve water quality conditions within the lake and throughout the watershed. Work to secure additional funding to improve bank stabilization, fish habitat, and water quality within the lake.